DOES THE UNITED STATES NEED TO DEVELOP A NEW NUCLEAR
EARTH PENETRATING WEAPON?

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

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Fort Leavenworth, Kansas
2003

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY) 06-06-2003	2. REPORT TYPE thesis	3. DATES COVERED (FROM - TO) 05-08-2002 to 06-06-2003

4. TITLE AND SUBTITLE DOES THE UNITED STATES NEED TO DEVELOP A NEW NUCLEAR EARTH PENETRATING WEAPON? Unclassified	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Moore, Thomas, F	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Command and General Staff College 1 Reynolds Ave Fort Leavenworth, KS66027-1352	8. PERFORMING ORGANIZATION REPORT NUMBER ATZL-SWD-GD
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS ,	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
A1,Administrative or Operational Use
06-06-2003
US Army Command and General Staff College
1 Reynolds Ave
Fort Leavenworth, KS66027-2314

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Potential adversaries of the US have hard and deeply buried targets (HDBTs) that prevent their centers of gravity from being held at risk. All US services currently have programs aimed at defeating these HDBTs. Both conventional and unconventional techniques have shown promising results. Despite these efforts, nothing in the US inventory, to include nuclear penetrators, can defeat the hardest of deeply buried targets. The current administration has taken steps that open the possibility of developing a new nuclear weapon. Critical nuclear research programs, DOE national laboratories and testing infrastructure, as well as DOD nuclear supporting facilities, have received large funding increases. The National Security Strategy and the Nuclear Posture Review both support this end. Furthermore, a feasibility study has been proposed to Congress to investigate a robust nuclear earth-penetrating weapon. This thesis analyzes the primary thesis question using a strategic policy test incorporating feasibility, acceptability, and suitability. The determination is that the US does need a new nuclear earth-penetrating weapon and offers recommendations for the path forward.

15. SUBJECT TERMS
Nuclear Weapons; Nuclear Posture Review; Nuclear penetrators; Buried targets; National Security; Research programs

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 65	19. NAME OF RESPONSIBLE PERSON Buker, Kathy kathy.buker@us.army.mil
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 9137583138 DSN 5853138

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39.18

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

DOES THE UNITED STATES NEED TO DEVELOP A NEW NUCLEAR EARTH PENETRATING WEAPON? by Major Thomas Moore, United States Army, 59 pages.

Potential adversaries of the US have hard and deeply buried targets (HDBTs) that prevent their centers of gravity from being held at risk. All US services currently have programs aimed at defeating these HDBTs. Both conventional and unconventional techniques have shown promising results. Despite these efforts, nothing in the US inventory, to include nuclear penetrators, can defeat the hardest of deeply buried targets.

The current administration has taken steps that open the possibility of developing a new nuclear weapon. Critical nuclear research programs, DOE national laboratories and testing infrastructure, as well as DOD nuclear supporting facilities, have received large funding increases. The National Security Strategy and the Nuclear Posture Review both support this end. Furthermore, a feasibility study has been proposed to Congress to investigate a robust nuclear earth-penetrating weapon.

This thesis analyzes the primary thesis question using a strategic policy test incorporating feasibility, acceptability, and suitability. The determination is that the US does need a new nuclear earth-penetrating weapon and offers recommendations for the path forward.

ACKNOWLEDGMENTS

I would like to thank my committee members for their guidance, encouragement, and critical eye throughout this project. Additionally, I would like to thank my two sons Quinlan and Colin, as they are the main source of inspiration in all my endeavors.

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ACRONYMS

BROACH	British Bomb Royal Ordnance Augmenting Charge
CALCM	Conventional Air-Launched Cruise Missile
DTRA	Defense Threat Reduction Agency
EPW	Earth Penetrating Weapon
FAS	Feasibility, Acceptability, and Suitability
HDBT	Hard and Deeply Buried Target
HUMINT	Human Intelligence
ICBM	Intercontinental Ballistic Missile
JROC	Joint Requirements Oversight Council
JSOW	Joint Standoff Weapon
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
MNS	Mission Needs Statement
NMS	National Military Strategy
NNSA	National Nuclear Security Administration
NNWS	Nonnuclear Weapon State
NPR	Nuclear Posture Review
NPT	Nuclear Non-Proliferation Treaty
NSS	National Security Strategy
NWC	Nuclear Weapons Council
NWS	Nuclear Weapon State
RNEP	Robust Nuclear Earth Penetrator
USFK	United States Forces Korea

CHAPTER 1

INTRODUCTION

The US’ potential adversaries have an increasing number of hard and deeply buried targets (HDBTs) that may be too impenetrable to hold at risk with conventional weapons. This takes into account the technological advancements of "smart" munitions and fuses. These facilities conceal not only strategic weapon systems, but also other facets of their military instrument of national power, including command and control nodes, chemical and biological weapon facilities, weapon stockpiles, and sanctuaries for their national-level leadership. Weapons of mass destruction (WMD) facilities warrant special consideration, as either a conventional or nuclear attack would present risk due to a potential release of a chemical or biological agent into the atmosphere. Ironically, scientists argue that a nuclear attack on such facilities would have less collateral damage because the thermal effects of a nuclear explosion would vaporize the potential chemical or biological hazard.

By design, HDBTs are difficult to characterize. Satellite imagery can reveal their existence, but not necessarily their function. These potential targets offer a tremendous challenge to the US. They are difficult to engage: above ground, they do not offer the typical silhouette of a more conventional target; below ground, they may be dispersed through an array of interconnecting tunnels. Their great depth and reinforced cover are, by design, difficult to destroy. If the US attacked an HDBT with a conventional or nuclear warhead there would still be the problem of damage assessment. Satellite or unmanned aerial vehicle imagery may provide confirmation that the munition

successfully exploded on the target; however, the facility may still be intact deep underground. To complicate the process, US leadership may have to provide proof to the world that a military response against a particular HDBT was justified. Adversarial propaganda could easily purport that the US destroyed a pharmaceutical research laboratory or similar benign facility. This may place the US in a position that is difficult to refute without sacrificing key HUMINT or other national intelligence sources.

During the 'Cold War' the United States dealt with similar challenges presented by the former Soviet Union's formidable intercontinental ballistic missile (ICBM) sites. Despite the dispersion and hardened measures of protection, there was confidence that the US could destroy these targets even in the context of a full nuclear exchange, commonly referred to as the deterrence strategy of mutual assured destruction. If the US does not have confidence that its conventional munitions can destroy an adversary's center of gravity, the option of employing nuclear weapons must be evaluated. Although a nuclear weapon would certainly increase the probability of target destruction, there are a myriad of issues associated with its use.

The US has the distinction of being the only country to use nuclear weapons in conflict. Since these actions in 1945, several events transpired that bear on my primary question of developing a new nuclear earth penetrator. The US is one of five nuclear weapon states (NWS) that signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1968. In addition to preventing the proliferation of nuclear weapons, the treaty proclaims that NWS will not use a nuclear weapon against NPT signatories from nonnuclear weapon states (NNWS). This may place the US in a quandary. In President George W. Bush's 2002 State of the Union Address he labeled Iran, Iraq, and

North Korea as the “Axis of Evil” because of their persistence in developing weapons of mass destruction (WMD) programs. Iran and Iraq are both NPT signatories and NNWS. Additionally, some countries that the US is engaging in the Global War on Terrorism fall into this category as well. While the US intervened in Iraq, North Korea lived up to the President’s label by admitting they have been covertly developing nuclear weapons.

In response to tensions on the Korean peninsula, the Clinton administration crafted the 1994 Agreed Framework. Simply stated the agreement called for Pyongyang to freeze operations of its nuclear reactors in exchange for two US-built light-water reactors. The US would additionally supply fuel oil until construction of the reactors was completed. North Korea’s admission to running a covert nuclear weapons program is a clear violation of this bilateral agreement. Nuclear weapons on the Korean peninsula not only put relations with the US in jeopardy, they also create a new strategic security paradigm in Northeast Asia.

Regardless of the NPT framework, a third use of a nuclear weapon against any country would have significant political consequences internationally and within the US. Even a nonstrategic weapon with a very low nuclear yield that was delivered precisely on a target may still be a strategic event in worldwide public opinion.

It is critical to our national security that potential adversaries have no sanctuary from which they can launch an attack against the US or its allies. If the advanced engineering efforts representative in current HDBTs nullify conventional munitions, potential adversaries may have such sanctuary.

During the Gulf War the Guided Bomb Unit-28 (GBU-28) was developed in an effort to penetrate hardened Iraqi command centers. This 5,000-pound laser-guided

system used a modified 203-milimeter artillery tube as its penetrating casing. After an extremely quick acquisition and testing process this weapon was delivered to theater and used against Iraqi command and control sites. If some twelve years ago the US had to develop a new conventional system to hold an HDBT at risk, it would be logical to assume that the current set of HDBTs may be impenetrable from anything in the US conventional inventory. Moreover, in 1993 Secretary of Defense Les Aspin changed US policy in relation to WMD by the introducing the Defense Counter-Proliferation Initiative. This initiative called for a military response towards the proliferation of WMD. Specifically, it asked for the development of improved nonnuclear weapons capable of destroying HDBTs. Currently, the US Army, Navy, and Air Force are all modifying and demonstrating conventional weapons to support this vision. Additionally, the current Defense Planning Guidance has requested exploration and demonstration of HDBT defeat by special operations and information operations through nonkinetic means.

The US use of a nuclear weapon, regardless of yield, may be unimaginable. If, however, the US decided to use a nuclear weapon, it is important to fully understand all the resulting collateral effects. With the recent development of the B61 modification 11 (B61–11), a modification of an existing weapon, the US administration had enough assurance to retire the aging B53, a ‘bunker-buster’ weapon that produced a great yield. The B61-11s physics package was not altered; rather nonnuclear components were changed and hardened to provide an earth-penetrating capability. It is not clear, however, that this bomb can address the myriad of emerging target sets that are under the ground. In unclassified sources, scientists relatively agree on the earth-penetrating depth of a B61-11. The yields are also known. Therefore, the combination of this information with

intelligence on the depth, size, reinforcement materials, and geology of a HDBT could determine its effectiveness against a particular HDBT. The fact that a B61-11 could destroy an individual HDBT is critical to military planners, but other nuclear issues, such as collateral damage, electromagnetic pulse, fallout, and strategic and political implications would have to be weighed in the decision process. Some existing treaty obligations may prove to facilitate that decision.

Under the Clinton administration, the US Congress voted against ratification of the 1999 Comprehensive Test Ban Treaty (CTBT). The CTBT would have precluded signatories from detonating nuclear explosions and would have deterred the development of modern nuclear weapons systems. Therefore, it is plausible that the directors of the Department of Energy's (DOE) national laboratories have their scientists researching new nuclear weapon system designs. If one of the DOE laboratories developed a new nonstrategic weapon designed to defeat HDBTs, there would still be the question of whether or not the new design would work. Demonstration of the effectiveness on a mock target could only follow testing of the basic design function. This would violate the US moratorium on nuclear weapons testing, and it would take several months, if not years, to certify the new weapon. Additionally, these actions would be difficult to do covertly and the lengthy process may thwart any element of surprise that the US would like to achieve. The act of resurrecting a nuclear weapons testing program would produce an outcry from antinuclear activists, members of Congress, and the international community. It could, however, have a potential beneficial effect of a clear demonstration of US resolve.

Research Objective

Primary Research Question

The central purpose of this study is to determine if the US needs to develop a new nuclear earth-penetrating weapon (EPW).

Subordinate Research Questions

The following three secondary questions are vital to the answer of my primary research question. First, it is necessary to know what EPWs are in the US inventory. It is important to understand the full range of available options and their capabilities and limitations to address HDBTs. Second, Are there HDBTs that cannot be defeated by a conventional warhead? This question is important because if conventional munitions can defeat all the HDBTs with which the US is concerned, a new nuclear weapon may only be desired to address an emerging threat. Third, Are there factors that would impact the US decision to develop a nuclear EPW even if it appeared to clearly be in the US' best interest to do so? For example, treaty requirements and limitations, strategic implications, relations with our allies and other NWS, and implications of US provocation all deserve evaluation.

Limitations

The research of this thesis is restricted to unclassified sources. Additionally, due to my location in Kansas, I am physically removed from some of the work that is being conducted on HDBTs in Albuquerque, New Mexico and in the Washington DC area. Therefore, firsthand reports are a result of electronic media and telephone interviews. Lastly, the focus of this thesis to develop a new nuclear EPW is in response to HDBTs vice any other targets.

Definitions

It is important to understand the term hard and deeply buried target. In the context of this thesis I will use the definition that was used by Secretary of Defense Rumsfeld in his July, 2001 Report to Congress:

> An adversary's threatened and well-protected assets in structures ranging from hardened surface bunker complexes to deep tunnels. These facilities are typically large, complex structure incorporating the attributes of concealment, self-sustainment, multifaceted communications, strong physical security, modern air defenses, and sitting in protective (often mountainous or urban) surroundings. In many countries, HDBTs are elements of a well-connected network of operational capabilities with duplication a very important factor for both intelligence and strike planning. These facilities are protected for good reason they are an essential element of any likely battle or crisis action. Such facilities routinely serve as: leadership shelters; command, control, and communications (C3) centers; weapons production, assembly, storage and deployment facilities, especially for weapons of mass destruction (WMD); missile operations tunnels and garrisons; and point or integrated area defense system facilities.

The definitions of the following terms are taken from Joint Publication 1-02 (23 January 2002).

Nuclear Weapon. A complete assembly (i.e., implosion type, gun type, or thermonuclear type), in its intended ultimate configuration which, upon completion of the prescribed arming, fusing, and firing sequence, is capable of producing the intended nuclear reaction and release of energy.

Weapons of Mass Destruction. Weapons that are capable of a high order of destruction and/or of being used in such a manner as to destroy large numbers of people. Can be nuclear, chemical, biological and radiological weapons, but excludes the means of transporting or propelling the weapon where such means is a separable and divisible part of the weapon.

The definitions of the following terms are taken from Technical Publication 4-1, Glossary of Nuclear Weapons Materiel and Related Terms (1 August 1988).

Nuclear Yields. The energy released in the detonation of a nuclear weapon, measured in terms of the kilotons or megatons of trinitrotoluene required to produce the same energy release. Yields are categorized as: very low--less than one kiloton, low--one to ten kilotons, medium--over ten kilotons to fifty kilotons.

Pit. The components of a nuclear assembly system (NAS) located within the inner boundary of the high explosive (HE) but not including safing materials or stress cushions.

Significance of the Study

This study of developing a new nuclear EPW is extremely important to the US National Military Strategy. The ability to project military power has been a strong suit for the US for decades. It is the opinion of the author that during this same time frame, tactics, leadership, and national resolve were more at cause for failing to achieve national objectives than technological capabilities. We may now be approaching an era where our technological advantage may not serve as a force multiplier. If we do not look at all viable alternatives, potential adversaries will be free to execute WMD programs safe from the US' purview. The HDBT issue also has Congressional concern. Congressman Floyd D. Spence's Authorization Act of Fiscal Year 2001, Public Law 106-398, required the Secretaries of Defense and Energy to report on the defeat of hardened and deeply buried targets and chemical and biological agents. The resulting July 2001 report to Congress will be one of the current sources that I will use in this study.

CHAPTER 2

LITERATURE REVIEW

The majority of documentation addressing whether the US should develop a new nuclear EPW is very topical, partly theoretical, and certainly controversial. Furthermore, subject matter experts in this field are forced to contend with being loyal to scientific research and US government policy simultaneously. Subsequently, proponents and opponents of a nuclear EPW seem to fall into predictable patterns based on their employer. Therefore, I will discuss this research in a few broad categories.

The first category is US officials and the resulting policies, treaties, and congressional language that they develop. The Departments of Defense, Energy, and State employ the majority of these individuals. DOD officials recognize the strategic importance a nuclear EPW can have against HDBTs in relation to national security. Some of these individuals are also national policy makers and influence decisions to invest the nation's capital on nuclear matters. DOE officials, responsible for building and maintaining the US nuclear inventory, have vested interests in developing nuclear weapons. The majority of research from these officials favors nuclear solutions to HDBTs; however, they still advocate conventional solutions as well. The resulting US policies, treaties, and congressional authorizations shape the environment and set the guidelines under which these officials operate. They also offer a glimpse at the direction the nation will follow in nuclear matters.

The second group is the scientific community. Their writings attest to the effects, capabilities, and limitations of EPWs, as well as the feasibility of building a new nuclear

EPW. This community has overlap with the first, as many of these scientists hold key positions in government or at the DOE's laboratories.

Lastly is the conventional research that addresses solutions to HDBTs. Despite any perceived positions of nuclear advocates, all communities are actively developing conventional technologies to answer the HDBT question.

Policy, Treaties, Congressional Authorizations

The previous chapter highlighted the significance of the US' decision not to ratify the CTBT and how that could simplify the conduct of a future nuclear test. It also discussed the restrictions the NPT placed on developing a new nuclear weapon. As a signatory of the NPT, the US agreed (under Article VI) to completely dismantle its nuclear inventory. Despite this commitment, the January 2002 Nuclear Posture Review (NPR) revealed that complete nuclear disarmament is a long way off. The US currently plans to have only 1,700-2,200 operationally deployed warheads by 2012. The US' major policy change toward WMD and the emphasis on conventional solutions introduced by Secretary Aspen's Counter-Proliferation Initiative was also highlighted in chapter one. This initiative and the preceding two treaties helped form the strategic context for nuclear policy decisions of the Clinton and Bush administrations.

President William J. Clinton's Administration

Under the National Defense Authorization Acts of 1997 and 1998, Congress established a commission to look at maintaining US nuclear weapons expertise. Admiral H.G. Chiles, Jr. (United States Navy, Retired) chaired the commission and developed recommendations on specific strategies for recruiting and retaining the scientific, engineering, and technical personnel needed to maintain a safe and reliable nuclear

weapons stockpile. Energy Secretary Bill Richardson was briefed on the findings of this commission. Two of the results in this brief are important to this thesis. First, the DOE was asked to put renewed emphasis on the recruitment and retention of nuclear personnel, ensuring that the nation employs the best and brightest designers for its nuclear weapons programs. Second, the DOE and the DOD were asked to streamline their budget and program coordination to better meet national security objectives. In 1997 the DOD responded by releasing the first annual Nuclear Mission Management Plan to complement the DOE's existing Stockpile Stewardship Plan. The DOE's plan, also referred to as the "Green Book," serves as a guide for science-based stockpile stewardship as a result of the restriction on actual nuclear tests. This was the first formal step of integrating both departments' nuclear programs from initial requirement to ultimate dismantlement.

In October 1998, Senator Strom Thurmond's National Defense Authorization Act of 1999 created a panel to assess the reliability, safety, and security of the US' nuclear stockpile. Dr. John Foster, a former Director of Lawrence Livermore National Laboratory (LLNL), headed this panel. The panel's 28 September 1999 report to Congress had two significant recommendations that could open the door towards the development of a new nuclear weapon. The first was that the US should achieve adequate plutonium pit production capability to meet its future nuclear stockpile needs. The "pit" or nuclear core is the special material located within the inner boundary of the high explosive assembly of a nuclear weapon. Also, the panel asked the DOE to assess scenarios for possible nuclear tests and to prepare these plans annually.

President George W. Bush’s Administration

The Bush administration has placed renewed emphasis on the US nuclear infrastructure. Moreover, they have crafted policy that has increased the likelihood of using a nuclear response option. In the US National Security Strategy signed 17 September 2002, President Bush said that in the interest of national security, nations under imminent threat are within the guidelines of international law to take “preemptive action.” Specifically he stated, “To forestall or prevent such hostile acts by our adversaries, the United States will, if necessary, act preemptively.” This new preemptive strategy is a significant change in US national strategy and serves a strong notice to potential adversaries of the US.

The NPR released in January 2002 reinforces the administration’s focus on HDBTs and the importance of developing the full range of options to defeat them. Of significance, the NPR states that conventional weapons cannot complete the physical destruction of all HDBTs. It also calls for an acceleration of DOE’s nuclear test readiness. While these two statements present a coup for nuclear advocates, the NPR also calls for improved conventional capabilities that could be used against HDBTs. Perhaps the most significant part of the NPR is the concept of a “new triad.” The former nuclear triad consisted solely of submarine launched ballistic missiles (SLBMs), bombers, and intercontinental ballistic missiles (ICBMs). The new triad integrates all three of these nuclear systems with “nonnuclear” strike capabilities. The other two pieces of the “new triad” are “defenses” and “responsive infrastructure.” The integration of conventional and nuclear weapons as one leg of the triad is important. It portends that the most appropriate weapon (nuclear or conventional) will be used to achieve a strategic purpose.

Funding of $15 million has been proposed for research into a "robust nuclear earth penetrator" as part of the government's draft Defense Authorization Bill for 2003. This bill has yet to pass the Senate Committee on Armed Services (Hambling 2002, 1). According to Andrea Widener's 13 November 2002 *Contra Costa Times* article, "Bunker Buster Bomb is on Hold," Lawrence Livermore and Los Alamos laboratories are the two laboratories that will conduct a review to determine if the nuclear penetrator is feasible.

The three national weapons laboratories have enjoyed significant budget increases under the past two administrations. In an editorial in the *San Francisco Chronicle*, 22 October 2002, Sterngold reported that the weapons laboratory budgets grew to $6.2 billion dollars this fiscal year, up from their previous funding low of $3.2 billion in fiscal year 1995. He added that this money is being used in the design work of nuclear weapons. In February 2002, General John Gordon (United States Air Force, Retired), head of the National Nuclear Security Administration (NNSA), told a Senate committee that "laboratory teams will carry out theoretical and engineering design work on one or more concepts, including options to modify existing designs or develop new ones" (Bromley, Grahame, and Kucia 2002, 23). Title 32 of the National Defense Authorization Act for fiscal year 2000 established NNSA as a semiautonomous agency within DOE. It provides management and budget oversight of the nuclear weapons, nonproliferation, and naval reactor programs.

Nuclear testing is necessary for the validation of a new nuclear weapon design or possibly for a modification of an existing nuclear weapon. Congress has spent millions of dollars over the last couple of years in increasing the preparedness of the nation's premier nuclear testing ground, the Nevada Test Site. These dollars are directed at reducing the

time it would take the nation to conduct such a test. Sterngold's report stated that this investment may reduce the time to conduct a nuclear test from approximately three years to only six months.

The preceding paragraphs offer many examples of US investment and interest in the nuclear infrastructure. These efforts are still far removed from any actual authorization and development of a new nuclear EPW. Much of the scientific community that would be consulted on such an enterprise, however, is against developing a new nuclear EPW.

Scientific Community

Opponents

The primary concern of scientists against a nuclear EPW is the issue of collateral effects. For example, Dr David Wright, a nuclear weapons expert at the Union of Concerned Scientists in Washington DC, wrote a paper entitled *Earth-Penetrating Weapons.* In this paper he claims that the US already has around fifty 'penetrating' nuclear weapons in its stockpile, but these can only reach a depth of six meters in earth. He goes on to say that this would not be nearly enough to contain the resulting radioactivity. He adds that for a very low yield (0.3 kiloton explosion), a burial depth of about seventy meters in dry soil and about forty meters in hard rock is required to contain the blast. Dr. Robert Nelson, a Princeton University physicist at the Federation of American Scientists, concurs with these findings. In his article entitled *Low-Yield Nuclear Earth-Penetrating Weapons* he states that the earth-penetrating capability of US nuclear weapons is only twenty feet. Additionally, he claims that if a low yield nuclear pentetrator was detonated at this depth the nuclear blast would simply blow out a huge

crater of radioactive material, creating a lethal gamma radiation field over a large area. He attests that a burial depth of 230 feet is required to contain the nuclear yield of just 0.1 kiloton.

An EPW, by design, will always create an opening in the earth that could serve as a “chimney,” facilitating the release of radiation. Therefore, there is no disagreement within the scientific community that the use of a nuclear EPW will always release some level of radiation into the atmosphere.

Another concern about the development of nuclear EPWs is that it may increase the likelihood of a nuclear exchange. Dr Nelson believes that the development of new nuclear EPWs, rather than deterring conflict, would increase the likelihood of its use. Additionally, he has concern that such a weapon would be used in a “conventional” conflict with a third world nation vice an NWS.

In an editorial in the New York Times, 11 March 2002, Dr. Frank von Hipple, a former advisor to President Clinton, said that the task to build a nuclear EPW would be daunting. Developing a small nuclear system capable of functioning after smashing through several layers of rock is no small task. Dr. von Hipple added that, “It is not clear that there’s much additional technology that could be developed against underground targets.”

Proponents

Dr Stephen Younger, currently the Director of the Defense Threat Reduction Agency (DTRA), has authored numerous works on nuclear weapons and was the Associate Laboratory Director for Nuclear Weapons at LANL. In his paper *Nuclear*

Weapons in the Twenty-First Century he acknowledged the need to address the US' future nuclear force in relation to the long acquisition and development cycle:

> Now is the time to reexamine the role and composition of our future nuclear forces. New technologies take at least a decade to move from the concept stage to the point where we can rely on them for our nation's defense. And, advance planning is already under way for the replacements of our nuclear capable missiles, aircraft, and sub-marines. Prudent thought given to this crucial subject will reap great dividends for the United States and peace in the world (Younger 2000, 2).

Dr. C. Paul Robinson, President and Director of Sandia National Laboratory, produced a "white paper" entitled *Pursuing a New Nuclear Weapons Policy for the Twenty-First Century*. He speaks of the necessity of using nuclear EPWs to counter HDBTs.

> In a somewhat obvious way, aside form the still perplexing issues of how to hold at risk hardened or deeply buried underground targets, I believe that we would desire primarily low-yield weapons with highly accurate delivery systems for deterrence in the non-Russian world. Here, I'm not talking about sub-kiloton weapons (i.e., "mini-nukes") as some have advocated, but devices in the low-kiloton regime, in order to contemplate the destruction of some buried or hidden targets, while being mindful of the need to minimize collateral damage. I believe we can achieve the low-yield levels that are likely to be most appropriate for deterring wider low-yield levels threats, particularly if we are unable to design and test new weapons under a nuclear testing moratorium, by depending on the features inherent in many designs in the current U.S. stockpile. An obvious and also very effective approach to obtain low-yield devices would be to use dummy secondaries as a way of quickly achieving single-stage yields (primary-only yields) without having to modify the devices, or to repeat flight tests for the delivery systems, or to conduct additional nuclear testing. (Robinson 2002, 13)

The conclusion of this paragraph is significant, as Dr. Robinson exerts that an "effective" way to achieve a nuclear EPW capability is to use a weapon from the existing nuclear stockpile. His conclusion is made in the context of the current US moratorium on nuclear testing.

Conventional Technologies

The Office of Naval Research, the DTRA, and Lockheed Martin are working on a promising advanced concept technology demonstration, entitled Agent Defeat. This program, now in its second phase, focuses on destroying chemical and biological agents in such a fashion as to prevent any collateral damage from a toxic vapor hazard. The specialized fill being developed is intended for the existing 2,000 lb BLU-116 penetrating warhead on the GBU-24 laser-guided bomb, and the 2,000 lb BLU-109 penetrator on a joint direct attack munition. Andrew Koch, in the 18 September 2002 *Jane's Defence Weekly*, describes the concept of this special fill in his article entitled "USA Expedites Chem-Bio Bunker-Buster Project."

> The concept involves 300 lb (136kg) of a two-stage reactive and pelletised mix of 'titanium boron lithium perchlorate intermetallic high-temperature fill' that burns at 1,000ºF (538ºC) for a long time and with low overpressure so any remnants are not ejected from the facility. As a by-product of the HTI reaction, 35 lb (15.8kg) of disinfecting monatomic chlorine and monatomic fluorine gas, along with hydrochloric and hydrofluoric acid, will be left to destroy any remaining BW agents.

Microwave technology is another emerging technology that has implications in the defeat of HDBTs. US defense and industry officials suggest that a high-powered microwave (HPM) weapon is close to operational employment. In a related 9 August 2002 *Jane's Defence* article called "US/DOD Push for Laser, Microwave Oven" Koch says that Mike Booen, Vice President for Directed-Energy Programs at Raytheon, claims that high-powered microwave and laser weapons are on the verge of moving from the science and technology phase into the tactical platform phase. These weapons could be used to destroy CW/BW agent production equipment by burning out electronic and

computerized controls. Likewise, computer network attacks could shut down key infrastructures or simply make the sites untenable by cutting off their electricity.

The Special Operations Command is working on several programs that have implication for the defeat of HDBTs. They are the lead for techniques to seize and effectively neutralize a facility. In addition to these "take down" options, they are testing substances, such as sticky or hardening foams, that could prevent entry or exit within an underground facility. Although they have the difficult task of gaining proximity to an HDBT, they can provide firsthand observations on weapons effects or confirm intelligence estimates through simple reconnaissance.

Similarly, each service is working on conventional programs as solutions to HDBTs. The 2001 *Report to Congress on the Defeat of HDBTs* summarizes their major efforts. The US Air Force is focusing on the development and production of existing penetrating weapon designs. In addition to their GBU-28 program, they are equipping fifty conventional air-launched cruise missiles (CALCMs) with a penetrating warhead based on the advanced unitary penetrator bomb. The foundation of this technology is a hard target smart fuze that provides void and layer counting. Simply stated, this fuze can detonate at a predetermined level within a facility.

The Navy is working on internal programs while assisting the US Army and British government. The Navy's internal focus is on the penetrating capabilities of Tomahawk land attack and supersonic cruise missiles. They are also invested with the Army on the Tactical Missile System Precision Penetrator Program. The Pacific Command is the sponsor of this advanced concept technology demonstration (ACTD), which uses the Army's multiple launch rocket system as the launch platform. Lastly, they

are developing a variant of the joint standoff weapon (JSOW) with a penetrating warhead, which incorporates the British bomb royal ordnance augmenting charge (BROACH) technology.

These conventional efforts to defeat HDBT are promising. Unfortunately, sources confirm the belief that conventional weapons cannot defeat the most challenging HDBTs. This highlights the importance of continued investment in conventional technologies while giving nuclear EPWs increased viability. In the next chapter I will weigh these policy considerations in terms of what is most feasible, acceptable, and suitable for national security.

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this study is to determine if the US needs to develop a new nuclear EPW. To adequately answer this question I developed several secondary questions that need to be answered in support of my primary question. This "pyramid" type of logic focused my research into several broad areas, highlighted in the previous chapter. While some of the answers to these questions are easily and objectively answered, the preponderance of the information is subjective. Therefore, I will apply a tested and recognized method of evaluating strategy in pursuit of the answer to my primary question.

The DOD uses a strategic policy test to evaluate the impact strategic decisions have on national security. Appendix B of DOD Joint Publication 3.0, *Doctrine for Joint Operations*, states that this method may be used for testing a "strategic course of action" (Department of Defense 2001). This standard is known as the "FAS test." The acronym stands for feasibility, acceptability, and suitability. This term is defined in Joint Publication 1-02, the *Department of Defense Dictionary of Military and Associated Terms*, as follows (United States Department of Defense 2000):

> Feasibility--The determination of whether the assigned tasks could be accomplished by using available resources.
>
> Acceptability--The determination whether the contemplated course of action is worth the cost in manpower, material, and time involved; is consistent with the law of war; and militarily and politically supportable.
>
> Suitability--The determination that the course of action will reasonably accomplish the identified objectives, missions, or tasks if carried out successfully.

To answer my primary question, these three criteria will be evaluated against these areas of concentration addressed by my research pyramid.

Feasibility

Four areas are related to determining the feasibility of the US' development of a new nuclear EPW; the scientific community, the budget authorizations of the DOE and DOD, intelligence data on HDBTs, and the military's capability to deliver an EPW.

The scientific community can best postulate if a new nuclear EPW can be developed. DOE weapons designers specifically can attest to the feasibility of developing an EPW in relation to the availability of special nuclear materials, machining methods, etc. Additionally, they can assess if greater penetration depth (more than six meters) can be achieved and still produce a sizeable enough yield to defeat a specific HDBT.

This information is purely theoretical and will never come to fruition if the DOD does not have a valid requirement and the support of the current administration for a new weapon. Additionally, the DOE weapons laboratories and testing infrastructure must be properly funded to undertake the development of a new weapon system. Therefore, the budgets of both organizations are important in relationship to the feasibility of this study. The former, DOD, is reflective of the administration's intent towards the nuclear weapons program and the latter, DOE, reflects the feasibility of developing a new weapon by increasing capacity of the nuclear weapons complex. The DOD requirement for a new nuclear EPW would come from an HDBT that cannot be held at risk by any other means.

The intelligence community plays an important role in the defeat of HDBTs. They must be able to identify and characterize these facilities so military planners can make

effective targeting decisions. The more information the intelligence community provides on the number and location of portals, material construction, depth, and contents of an HDBT, the greater the probability of defeating it.

This is why HDBTs are significant to the feasibility of this study. They present a huge targeting challenge, as many HDBTs cannot be defeated by any of the EPW systems in the US inventory. The delivery of an EPW on target is contingent on the military for the appropriate delivery vehicle, whether from the air, the sea, or emplaced by a soldier. This capability is another aspect of the analysis of feasibility.

Acceptability

To determine the acceptability of my primary question I will analyze the following factors, political concerns and implications, costs, and proportionality and necessity in relation to the law of armed conflict.

Political concerns and implications extend from the treaties and policies that legally bind US actions to the perceptions of the American people, allies, and potential adversaries. Moreover, this factor is critical because the political framework often dictates what is acceptable for the security of the nation, regardless of a treaty constraint, public opinion, or cost.

The cost our nation may pay if we developed a new nuclear EPW is essential to evaluating the acceptability of this effort. Costs come in several forms. The first and least important is the cost in dollars that it would take to resurrect the nation’s nuclear weapons designing effort and testing infrastructure. More significant costs will be paid in public opinion, both within the US and amongst our allies and adversaries. If the US’ adversaries had knowledge of a new American nuclear weapons program, however, the

result may not be a cost, but rather a payback in effective deterrence. The ultimate cost, however, is measured in the loss of life that could result from the use of a nuclear EPW. The deaths of the most despised enemy may never again be justified if they are a result of an American nuclear weapon. Therefore, any response would have to be weighed carefully against the laws of armed conflict in relation to proportionality and necessity.

Suitability

To assess the suitability, or the reasonable accomplishment of the identified objectives, missions, or tasks if carried out successfully, it is necessary to have a vision of the motivation for the US to develop a nuclear EPW. As stated in my assumptions, the US will always develop systems that can hold adversaries' centers of gravity at risk. This is the most likely scenario that would drive the US to develop a new nuclear EPW. Two other scenarios are plausible by themselves while still supportive of my main assumption. All three will be addressed in my analysis to assess suitability.

The second possibility is that the US would develop a nuclear EPW in the interest of deterrence. In this scenario, the US would benefit from public recognition of its efforts in weapons design and possibly demonstrate the capability through a live nuclear test. This would send a strong message to potential adversaries concerning US resolve. Suitability in this scenario would be measured by reactions of potential adversaries. Possible favorable reactions would be surrendering WMD, signing nonproliferation treaties, and ensuring complete transparency of national defense efforts.

The national effort dedicated to the stewardship of the US nuclear stockpile is enormous. Similarly, an effort to resume nuclear weapons engineering, pit production, and testing is arguably more complicated. What is certain is that the skills required to do

the latter are perishing rapidly and are vital to US national security. Therefore, the nation’s other motivation may simply be to retain and hone valuable nuclear design and production capabilities and personnel. A successfully engineered and tested nuclear EPW would verify the nation’s ability and verify the suitability of this scenario.

The desire to defeat emerging HDBTs is the prime motivator for the US to develop a new nuclear EPW. It encompasses the previous two thoughts because developing a new nuclear weapon clearly demonstrates that the nation has the requisite skill sets and infrastructure required for nuclear weapons production. The resulting weapon would also serve as a deterrent if the world knew of its existence. Suitability in this, the most likely scenario, could be judged by the capability of the new weapon to destroy an HDBT.

CHAPTER 4

ANALYSIS

In this chapter I will use the “FAS Test” to analyze the strategic decision of developing a new nuclear EPW. My analysis is based on the several categories that will determine if my thesis question is feasible, acceptable, and suitable. I will address each of these categories individually and impartially in relation to its role within the FAS Test. The interpretation of these results will be the basis for my conclusion and recommendations in Chapter 5.

Feasibility

I will address four categories to analyze the feasibility of developing a new nuclear EPW. Feasibility can be determined by the following question: Can a new nuclear weapon be developed using the US’ available resources? The categories I will analysis to answer this question are the scientific community, budget authorizations, intelligence on HDBTs, and military capabilities.

Scientific Community

As discussed in chapter 2, many scientists are concerned about the dispersed radiological debris that would result from the use of a nuclear EPW, specifically as a result of the “chimney” that would be created in the earth’s surface upon impact. The true challenge is the ability to accurately quantify the resulting radiation from any given yield of weapon. In assessing feasibility, the concern is whether it is possible to design a new nuclear EPW that will go deeply enough and still function to deliver the ground shock required to defeat a specified HDBT with minimal collateral damage.

Byron Ristvet from the Defense Threat Reduction Agency (telephone interview, 10 January 2003) maintains that the B61-11 was modified to penetrate soil or frozen ground, not the solid rock and reinforced concrete structures characteristic of modern HDBTs. Therefore, the need to develop a more robust nuclear system may seem prudent. A new nuclear weapon would require the design and production of a nuclear pit. Based on an assessment of today's nuclear infrastructure, this may present a strong argument against feasibility.

As part of an environmental investigation of Rockwell International, the FBI raided and subsequently closed the DOE's Rocky Flats Colorado complex in 1989. This was the nation's sole nuclear-pit-producing facility. Unlike the other major nuclear powers, the US does not have a robust pit-production capability. In Admiral Ellis' 27 September 2002 senate confirmation hearing, he alluded to the fact that the US may develop a very limited pit-production capability. He was commenting on NNSA's concept of requirements for "plutonium pit production" when he stated, "[NNSA's] early analysis supports establishing a small interim pit-manufacturing capability at LANL to meet near-term pit requirements." This limited capability was confirmed in the House Policy Committee report entitled *Differentiation and Defense: An Agenda for the Nuclear Weapons Program*. It stated LANL has a "very limited capability" for nuclear pit production (Wilson et al. 2003, 12).

A "very limited capability" to manufacture nuclear pits is not sufficient for large production and sustainment of nuclear weapons. Therefore, it is more in the nation's immediate interest to modify an existing nuclear weapon to hold HDBTs at risk. In conjunction with improvised delivery techniques, it may have some increased deterrent

value. The fact that nuclear pit production is being resumed after some fourteen years of inactivity is significant. Three likely scenarios exist that would explain the need to resume pit production. The administration may be concerned with the reliability of a pit with regard to a specific nuclear weapon in the inventory. Secondly, this may be an opportunity to maintain these critical skills within the nuclear weapons complex. The last scenario is that the administration may be answering a requirement for a new nuclear EPW or similar low-yield weapon.

There is evidence that these latter two assumptions have merit. Nuclear planners will meet this summer (2003) to discuss limited production of nuclear weapons and the costs and benefits gained from resuming nuclear testing. In a 24 February 2003 *Sante Fe New Mexican* article entitled “New Bombs Amid New Threats,” Jeff Tollefson goes on to say that “New weapons might include so-called ’bunker busters,’ other small-yield bombs and high-radiation bombs [also known as reduced blast bombs], according to the documents, to revive the art of design and development of thermonuclear bombs to counter new threats in a post-Cold War world.” The article also stresses the emphasis on attacking chemical and biological facilities. These facilities are serviced well by the unique thermal blast effect produced by a nuclear weapon. “The proposed meeting appears to build on the Bush administration's nuclear strategy, which calls for enhancing the nuclear complex and shifts U.S. policy to allow for targeted nuclear strikes in countering enemy efforts to produce chemical, biological or nuclear weapons.” If planners openly discuss nuclear EPWs for the US’ future, they may reap dividends by looking at the past.

The 1987 Intermediate-Range Nuclear Forces (INF) Treaty eliminated the US' Pershing missile. This system was forward deployed in Europe in the US Army's Fifty Sixth Field Artillery Brigade. The missiles were feared by the Soviets because they were extremely precise and lethal. Pershing missiles were also mobile and subsequently difficult to find. They carried a single thermonuclear warhead with a variable explosive yield from five to fifty kilotons. One design of the Pershing-II had a reentry vehicle equipped with an earth-penetrating nuclear warhead. Dr. John Hogan, currently a senior scientist at the Sandia National Laboratory, was a former member of the Pershing Missile System design team. He discussed the unique capabilities of the Pershing II system and its ability to hold at risk all HDBTs of the former Soviet Union (telephone interview, 15 January 2003). "The Pershing II, with its accuracy of twenty-three meters circular error probable (CEP) and ability to deliver an earth penetrating warhead at any velocity between 1500-5000 fps into the earth at ninety degrees plus or minus twenty degrees angle of impact with less than a 0.2 (3 sigma) angle of attack, which are considered absolutely ideal conditions, it could hold at risk all the hard targets on the target list in Warsaw Pact within its range." In addition to the ability to penetrate, Dr Hogan added that, "The timing of the fuse was geared to the velocity at impact and was a variable timer that was adjusted for the depth-of-burst. The velocity of impact was chosen based on intelligence data on the best estimate of the target."

This remarkable system was a testament to US technological capabilities. Military planners could decrease the nuclear yield required to destroy a target because of its unprecedented accuracy and ability to penetrate. These two attributes are key factors in reducing collateral damage.

The Pershing II's accuracy was attributed to a terminal radar guidance system that utilized radar area correlation. Data from the advanced development flight tests at the US Army's Redstone Arsenal demonstrate that its capability to penetrate was without peer. Its earth-penetrating nose was sixty-four inches long, 6.7 inches in diameter, and weighed 390 pounds (Reynolds 1983, 16). This 16,476-pound ballistic missile's enormous terminal velocity (up to 5,000 fps), combined with an ideal angle of attack and large penetrating nose, could penetrate up to 260 feet prior to detonating its nuclear payload (Hogan, telephone interview, 15 January 2003).

Dr. David Wright of the Union of Concerned Scientists expressed his concern with nuclear penetrators in that they could only achieve approximately six meters and, therefore, would leave significant radioactive fallout. He added that for a very low yield (0.3 kiloton explosion), a burial depth of about seventy meters in dry soil and about forty meters in hard rock would be required to contain the blast. Princeton scientist Dr. Nelson portrayed an even less optimistic picture when he said that a penetration depth of 230 feet was required to contain the nuclear yield of just 0.1 kiloton. The Pershing II earth-penetrating capabilities far exceeded that of the US' current capability and achieved greater depths than both of these scenarios. At its lowest yield of five kilotons, there would certainly be radiological fallout; however, its penetrating depth would greatly decrease collateral damage. The amazing effectiveness of this system, designed decades ago, speaks highly for the feasibility of developing a new nuclear EPW capable of defeating a wide array of HDBTs.

Budget Authorizations

DOD and DOE budget authorizations and appropriations serve as clear indicators of the intentions of the administration’s nuclear weapons development philosophy. Without the requisite money for feasibility studies, research and development, design, and testing, a new nuclear EPW could never be produced. Recently, the Bush administration asked Congress to spend $15 million on the study of a robust nuclear earth penetrator (RNEP). The House Armed Service Committee (HASC) report (J.R. 4546, H. Rept. 107-436) supported this request. The Senate Armed Service Committee (SASC) report (S. 2514, S. Rept. 107-151), however, denied funding of the program until some stipulations were met. Section 3132 clarifies that the funding will not be approved until such time as the Secretaries of Defense and Energy report on the “military requirements, targets, employment policy, and ability of conventional weapons to attack targets that the RNEP may be intended for.” The fact that the HASC has promoted the research of an EPW and the SASC supports it, pending explanation from the Secretaries, is a big step for the nuclear weapons community. It certainly supports an argument for pecuniary feasibility.

Moreover, in a 3 February 2003 article from the *Los Angeles Times* entitled “Making Nuclear Bombs ‘Usable’,” Richard T. Cooper claims that a $1.26 billion program has been launched to develop computers that would help decide when nuclear weapons might be used to destroy deep underground bunkers. The basis for this program is an array of high-speed computers that could “process structural data on a HDBT, calculate the requisite amount of force needed for its destruction, and determine the suitability of a nuclear weapon.”

In addition, there have been significant budget increases to the nuclear programs of the three national weapons laboratories and the Nevada Test Site, presumably where the nation's next nuclear test will take place. All these factors support the administration's desire to address nuclear weapons solutions to HDBTs.

Intelligence on HDBTs

The fact that many studies have demonstrated that there are numerous HDBTs not held at risk by US conventional and nuclear weapons is fundamental to this thesis. In Admiral Ellis' 27 September 2002 senate confirmation hearing he articulated this national problem. When commenting on the HDBTs in which the US has interest, he stated, "Numerous studies over the last several years have identified facilities that are too hard and/or too deep to be held at risk by our current nuclear and conventional weapons." Additionally he did not rule out developing nuclear solutions to HDBTs when he stated, "A review of the full range of options the nation might pursue to deal with these facilities is a prudent and appropriate step at this time." During questioning of Secretary Rumsfeld at the SASC hearing on the fiscal year 2004 Defense Authorization, Senator Levin asked why a US $15 million study on RNEP would not be incentive for other countries to look at new ways of using nuclear weapons. Secretary Rumsfeld responded as follows:

> The world is experiencing an enormous amount of underground tunneling and activities; activities underground that are for production that are for manufacturing, that are for development, for storage. And the problem of not having visibility into them, and when one has visibility, not having the ability to penetrate and reach them, creates a very serious obstacle to US national security. And to the extent we say to ourselves, 'Well, that's going to be the ultimate solution, we're unwilling to even study the idea of penetrating capability,' and therefore we make it advantageous for people to engage in that type of tunneling, I think that it would create an incentive, rather than a disincentive.

This incentive that Secretary Rumsfeld discusses is not in the interest of US national security. His assertion is supported by the effect that Pershing II had on the former Soviet Union. The fact they knew the US had a system that could defeat their primary and retaliatory nuclear capabilities made the INF treaty all too welcome. Conversely, any country of concern that has its centers of gravity shielded by underground facilities, with no fear of annihilation, should be expected to exploit this advantageous position.

Even if the capabilities inherent in the Pershing II (a fifty kiloton detonation some 260 feet below the surface) could be replicated, they may not produce enough ground shock to produce the desired effects on the hardest of HDBTs. Instead they would require substantial yields.

As a result of years of nuclear tests, scientists have learned the significant differences in surface, air, and subsurface bursts. For example, a fully contained underground explosion would have little or no air blast, one of the primary effects of a low-air burst. The resulting ground shock of a contained (underground) nuclear detonation is the primary effect necessary to defeat HDBTs. The phenomenon is explained as follows:

> Much of the energy is expended in forming the cavity around the burst point and in melting the rock, and the remainder appears in the form of a ground shock wave. As this shock wave moves outward it first produces a zone of crushed and compressed rock, somewhat similar to the rupture zone associated with crater formation. Farther out, where the shock wave is weaker, the ground may become permanently distorted in the plastic (deformation) zone. Finally, at considerable distances from the burst point the weak shock wave (carrying less than 5 percent of the explosion energy) becomes the leading wave of a series of seismic waves. A seismic wave produces a temporary (elastic) displacement or disturbance of the ground; recovery of the original position, following the displacement, is generally

> achieved after a series of vibrations and undulations, up and down, to and fro, and side to side, such as are typical of earthquake motion. (Glasstone 1977, 238)

Whether a Pershing II could have defeated the robust HDBTs in the current US target set is debatable. The fact that the current US nuclear arsenal cannot is without dispute. When assessing US capabilities, it is important to recognize that such an impressive earth-penetrating system was developed with US technology that is over thirty years old. It is logical to make the assumption that advances in science, technology, and computing would allow the US to have a better "Pershing II" today. Likewise, it is important to recognize that the Pershing II was a ballistic missile. Unlike the missiles in ICBM fixed silos, however, Pershing missiles were in the hands of the field artillery and positioned tactically over the battlefield. Whether fixed or mobile, launching a ballistic missile is momentous and would be detected by ground and space radars and characterized at command centers worldwide. Contrasting to the release of a B61-11 from a stealth aircraft, a ballistic missile would immediately be judged as a strategic attack similar to a submarine or silo-launched ballistic missile. On the other hand, the ballistic option improves chances of deliver through an adversary's defenses while eliminating risk to pilot and aircraft.

Despite the fact that both weapons have strategic consequences, simply because they are nuclear weapons, a ballistic missile option would have great immediate negative connotations for the US. Consequently, it is prudent to examine all the techniques that can enhance current (air-delivered) US nuclear EPW capability.

Military Capabilities

In the realm of feasibility it is critical that the nuclear services can support the delivery of a new nuclear EPW on a desired HDBT. Because all services would be integrated into the decision and acquisition cycle of a new weapon, it is improbable to think that this may be an issue. For example, a recent ACTD resulted in the development and delivery of BLU-118/B "thermobaric" bombs against Al Qaeda caves. This is a good illustration of how the services are integrated in the development of a new weapon.

The thermobaric bomb answered the operational requirement to develop a weapon (with specified military characteristics) necessary to defeat equipment in complex tunnel targets. A 25 July 2001 point paper by DTRA's Lt Col Tom Ward describes the five requirement origins of the BLU-118/B. "The special CINC and Joint Staff requests for a tunnel defeat weapon, the Capstone Requirements Document for HDBTs, USFK Mission Needs Statement (MNS), Air Component Command/USSTRATCOM MNS (CAF 317-92), and the Joint Warfighter's Capability Objective of the Joint Warfighting Science and Technology Plan." Ward went on to depict the several agencies that were necessary to respond to these requirements. "DTRA was the technical manger, Commander, US Forces Korea was the operational manager, and the Naval Surface Warfare Center, Indian Head, led the payload development technical efforts. Finally, the Air Force Air Armament Center, Precision Strike System Program Office conducted the aircraft/weapon system integration." Thus, the Air Force, the service tasked to deliver the BLU-118/B, was well represented to ensure that the weapon and the delivery vehicle were fully integrated. The resulting weapon, however, did require new tactics, techniques, and procedures to be employed effectively against caves. This, however, was

not an oversight, but rather a matter of practicality based on the terrain in Afghanistan. To the credit of the Air Force, they had requested a specified "deliverable" of the program to be "validated by operational tactics to employ the TB [thermobaric bomb] system." (Ward 2001, 2)

Acceptability

There are three categories that I will examine to determine the acceptability of developing a new nuclear EPW. The definition of acceptability for this thesis could be stated in the following question: Is the development of a new nuclear EPW worth the cost in manpower, material, and time involved; would this endeavor be consistent with the law of armed conflict; and, finally, is it militarily and politically supportable? The three categories I analyze to determine acceptability are pulled directly from this question. They are cost, law of armed conflict, and military and political supportability.

Cost

Because the US enjoys the world's largest gross domestic product (GDP), the cost of developing a new nuclear EPW in terms of dollars is negligible. Currently 3.5 percent of the US GDP goes toward defense spending. While that does not sound like a large percentage, it is easier to comprehend when viewed in the context of the following information. According to 2002 *Allied Contributions to the Common Defense Report* presented to Congress, the US spent more on its defense than all the other NATO members combined. If the US nuclear program does not present a credible deterrent, the cost to national security could be enormous. Likewise, the US must not lose its edge in nuclear weapons design or the capacity to produce nuclear weapons.

The political costs of developing a new nuclear bomb would be high. The production of a nuclear EPW would eventually call for nuclear testing to confirm that the weapon works. This necessary step is currently prohibited by the NPT and against the 1992 self-imposed nuclear testing moratorium. Additionally, the type of test required may violate the Limited Test Ban Treaty. The administration would have to be prepared to receive heavy criticism from allies and constituents for such efforts. Conversely, the nation may gain added security presented by the deterrent value of a new nuclear EPW. This would take years to validate, but, if effective, history will favor the bold steps in changing nuclear weapons policy.

Law of Armed Conflict

For decades, there have been rules of international humanitarian law that limit a state's ability to wage war. The most pertinent provisions are found in the 1907 Hague Regulations and subsequent Additional Protocols. As a signatory to the 1949 Geneva Convention, the United States follows these rules of war in conflict. It is important to note, as spelled out in Joint Pub 3-12.1, *Doctrine for Joint Theater Nuclear Operations*, that "neither the law of armed conflict nor any other customary or conventional international law prohibits the use of nuclear weapons in armed conflict" (1996). With respect to determining the acceptability of using a nuclear EPW, it is important to understand two overarching concepts of proportionality and necessity.

The principle of proportionality places a duty on leaders to choose a form of attack that avoids or minimizes damage to civilians. In particular, the attacker should refrain from launching an attack if the expected civilian casualties would outweigh the importance of the military objective. Moreover, Protocol I, Article 57 (Precautions in

Attack) requires those who plan and or execute an attack to cancel or desist from the attack in such circumstances. Therefore, clearly articulating military objectives is essential in any conflict. They serve as basic framework for a commander to determine a proportionate response.

Military necessity is perhaps a more complex definition because it gives commanders some latitude for interpretation. Military necessity does not allow for military measures to be taken that violate the laws of war or that do not have a military purpose (that is, that are not intended to defeat the enemy, or that would excessively harm civilians or damage civilian objects in relation to the concrete and direct military advantage anticipated). The Geneva Convention states that military necessity does apply to measure that are essential to attain the goals of war, and which are lawful in accordance with the laws and customs of war. The Commentary to Protocol I subsequently refers to this definition by saying that it is based on, urgency, measures which are limited to the indispensable, the control (in space and time) of the force used, and the means which should not infringe on an unconditional prohibition. While military necessity does grant military planners a certain degree of freedom of judgment about the appropriate tactics for carrying out a military operation, the Protocol adds it can never justify a degree of violence which exceeds the level which is strictly necessary to ensure the success of a particular operation in a particular case.

The use of force provided to military commanders under the concept of military necessity is clearly linked with the rule of proportionality. It is unlikely that nuclear weapons used against civilian populated centers could ever again be in concert with these principles. However, it is probable that a remote WMD facility buried under ground

would be an appropriate target for a nuclear EPW. The unique thermal effects of nuclear weapons strengthen the argument for proportionality when attacking WMD facilities. Conventional technologies, on the other hand, may inadvertently create a hazard by dispersing these agents through the air as an unintended result of the attack.

Military and Political Supportability

As the body that delivers the nation's military instrument of power, the services must be able to support a new nuclear EPW. The assumption that the military would "go along" with the administration's decision to develop a new nuclear weapon may appear as a forgone conclusion. Despite some disagreement on competing program interests, the US military has supported the major decisions of its civilian leadership concerning nuclear matters. The reality, however, is that the military must first demonstrate a requirement for a new nuclear weapon system and then gain support of the administration through the Nuclear Weapons Council (NWC), the Joint Requirements Oversight Council (JROC), and civilian leadership for a program to be viable in the DOD acquisition cycle. If the administration were inclined toward nuclear solutions to military requirements, this process would obviously be expedited.

The former Military Liaison Committee reported through the Office of the Secretary of Defense to the Atomic Energy Commission on military matters concerning the nuclear weapons stockpile. This body was replaced in 1987 by the current NWC. Public Law 99-661, Section 179 of Title 10 of the US Code states that the NWC will "evaluate safety, security and control issues for existing weapons and for proposed new weapon program starts." This forum and its many subcommittees ensure new nuclear weapons will be supported by the military in terms of nuclear weapons safety, security,

and control. Additionally, one of the three standing members of the NWC is the Undersecretary of Defense for Acquisition Technology and Logistics. In concert with the other two members, the Vice Chairman of the JCS (who chairs the JROC), and a Secretary-of-Energy-appointed senior representative, the NWC integrates the acquisition, design, and delivery communities. While the military has a strong vote in the request to develop a new nuclear EPW, the civilian leadership would bear the brunt of justification to the American people and US Allies.

The US decision not to ratify the CTBT is significant as it simplifies the US' ability to conduct a nuclear test. Moreover, it gives the appearance that the administration is interested in keeping this nuclear option open. A nuclear test would be required to validate the design of a new nuclear EPW. As a signatory to the NPT, however, the US said that it would not develop any new nuclear weapons, and under Article VI of the NPT agreed to a complete dismantlement of its nuclear inventory. Although steps are being taken in the reduction of nuclear weapons, this commitment will not come into fruition anytime soon. According to the January 2002 NPR the US plans to reduce its number of operationally deployed warheads to 1,700-2,200 by the year 2012. This position is now legally binding as part of a recent bilateral agreement between the US and Russia. Presidents Bush and Putin signed the Moscow Treaty on Strategic Offensive Reductions on 24 May 2002. This treaty validates the exact numbers of US nuclear weapons reductions espoused in the NPR.

New Mexico's Senator Heather Wilson, Chair of the Subcommittee on National Security and Foreign Affairs, led a panel that called for the repeal of the 1993 law prohibiting research on low-yield (less than five kiloton) weapons and endorsed the

creation of "an active advanced development program" for ideas for new or modified nuclear weapons (Wilson 2003, 14). Additionally, this House report made four other recommendations for the one hundred and eight Congress that support a position intent on resuming nuclear weapons testing and development.

The first was to “accelerate the development of tools to detect, disrupt or defeat weapons of mass destruction before they can be used.” A second recommendation was to, “[r]equire and support a test readiness program that could achieve an underground diagnostic test within 18 months.” The third was “[s]upport the modernization of the NNSA complex of laboratories. . . so that the workforce will be fully capable of maintaining and certifying the nuclear weapons stockpile.” The last and strongest statement for the support of a new nuclear EPW was, “[s]upport the study and evaluation of munitions, including nuclear, to hold hard and deeply buried targets at risk” (Wilson et al. 2003, 14).

These recommendations are bolstered by and also build on the recommendation by previous nuclear reports. Senator Wilson’s report provides the work necessary to answer the recommendations of Admiral Chiles’ commission, which expressed such concern for the maintenance of US nuclear weapons expertise. Similarly supported are the two main recommendations made in Dr. John Foster’s 28 September 1999 report to Congress. The first was that the US should achieve adequate plutonium pit production capability to meet its future nuclear stockpile needs, the second being that the DOE assess scenarios for possible nuclear tests and to prepare these plans annually.

Suitability

In analyzing the suitability of developing a new nuclear EPW I will address two areas related to the following question: Will the development of a new nuclear EPW reasonably accomplish the identified objectives if carried out successfully? For the purpose of this analysis the objectives will be accomplished if the new nuclear EPW acts as a deterrent towards an adversary's persistence on developing HDBTs, and if the new EPW serves to revitalize the nuclear infrastructure.

Deterrence

The US has not used nuclear weapons in war since WWII; however, the ambiguous threat of use is still a key to deterrence policy. President Truman's use of the uranium and plutonium bombs in 1945 set this precedent. The Korean War was a perfect example. The United Nations force under American command had vetoed the use of nuclear weapons. "In seeking to break the deadlock of 1953, the administration dropped hints that this constraint might well be removed. The consequent progress at the armistice talks appears to have convinced the administration that America's nuclear superiority was. . . a powerful diplomatic lever" (Blechman & Powell 1982, 21). Potential adversaries have not forgotten the events over Hiroshima and Nagasaki. This knowledge, combined with a flexible nuclear policy that does not rule out first use and a new NSS that stresses preemptive attacks, is a formidable deterrent.

If the administration develops a nuclear EPW, it should openly demonstrate its effectiveness through a live test. Only in this way would adversaries appreciate the resolve of the US and the abilities inherent within the country's nuclear infrastructure.

The ability to hold enemy centers of gravity at risk serves as the ultimate deterrent. Throughout history, emphasis has been placed on technologies that disrupt the sanctuary of an adversary or, restated, his advantage over us. Potential adversaries are not in awe of the US nuclear stockpile; under the evolution of policies, such as "massive retaliation," the stockpile grew to deter the formidable Soviet Union. The use of one of these strategic weapons against a bad actor is not probable, hence, there exists little deterrent value. The development and demonstration of a very accurate small yield nuclear EPW, however, would be an excellent deterrent for those who continue to proliferate underground facilities.

Maintaining the Nuclear Infrastructure

The nation's nuclear infrastructure would get the boost it needs and the respect it deserves if the nation developed a new EPW. It would present the requisite challenges for nuclear weapon designers, test managers, and their facilities. Additionally, it would revive the competition between the two primary weapons-designing laboratories at LANL and LLNL that habitually competed against military requirements for the perfect nuclear weapon. For example, George Miller, a senior defense official used to defend LLNL's National Ignition Facility for years over accusations of mismanagement and cost overruns. The intent of this four billion dollar program was to replicate "…how a nuclear blast affects the materials inside a bomb" (Sterngold 2002, 4). With the resurgence in funding he now is on the offensive, touting its capabilities by saying "…how the most powerful laser in the world will advance weapons research by creating bursts of heat similar to those when a nuclear bomb explodes" (Sterngold 2002, 4).

A new nuclear weapon program is exactly what is needed to answer Admiral Chiles concerns about the nuclear workforce and its degrading skills. One of the recommendations his committee made was to "expedite improvements and efficient use of the nuclear weapons production complex" with the intent to ". . . enhance recruitment and retention, improve morale, and reduce maintenance costs" (Chiles 1999, 8). Nuclear weapons laboratories were on the "cutting-edge" and could draw the nation's best and brightest designers through the valued and challenging work they offered. Although this is partially true today, an active nuclear weapons development process would attract the nation's best and most dedicated to national security.

Increasing the supply of special materials vital to the nation's nuclear stockpile (plutonium 239, tritium, uranium 235 etc.) would invigorate the economy and hone the skills of this specialized workforce. The two primary facilities for uranium and plutonium production, started during the Manhattan project, were in Oak Ridge, Tennessee, and Hansford, Washington, respectively. They were funded $1,578,476,000 and employed hundreds of thousands of people in 1945 (Hewlett and Anderson 1972, 723-724). If the nation does not act, resumption of special nuclear materials programs may come from necessity rather than foresight. It is predicted that all three legs of our existing nuclear triad will require major modernization between 2020 and 2040 (Davis 1999, 330). Therefore, the design of a nuclear EPW would be very suitable for the personnel and equipment within NNSA's organization.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on my analysis in the previous chapter, it is my conclusion that it is feasible, acceptable, and suitable for the US to develop a new nuclear EPW. The interrelated steps necessary to undertake this process and some special considerations are addressed in my recommendations.

The US' current nuclear stockpile was developed to counter the threats of the former Soviet Union. During the evolution of the stockpile, nuclear policy was formed around the uncertainty of the former Soviet Union's intentions and within the context of an ideological East-West struggle. Consequently, the two nations invested substantially in their respective nuclear infrastructures. The resulting stockpiles could have assured the destruction of either country in a retaliatory strike. President Reagan's controversial decision to position one of the US' best nuclear earth-penetrating weapons, the Pershing II, in Europe helped bring about an end to this escalation. Currently, bilateral nuclear reductions and confidence-building measures are working to address the myriad issues common to both nuclear programs. Furthermore, after decades of designing, developing, and testing nuclear weapons, the US ironically emerged as the key figure to help this former adversary dismantle and safeguard its nuclear materials.

The present day US nuclear arsenal does not deter states of concern from pursuing their WMD facilities. Unlike the scenario with the former Soviet Union, it is not necessary for them to endure the burden of investing large percentages of their GDP into weapons programs that could counter US capabilities. Rather, there is a relatively cheap

unspoken incentive to continue the current trend of operating and expanding underground WMD facilities, command and control structures, and leader sanctuaries. North Korea's production of nuclear weapons and resumption of their nuclear reactors despite the 1994 Agreed Framework and 1968 NNPT is just one example of the deterrent failure of the US' nuclear stockpile. In point of fact it is illogical for an adversary to think that the US, a country consumed by preventing collateral effects, preserving human rights, and enforcing the law of war, would use a strategic nuclear weapon against an HDBT in an underdeveloped country. This is especially true if it is a state, unlike North Korea, that does not have a nuclear capability of its own. The B61-11, despite its inability to destroy all HDBTs, is a more credible deterrent, because it is a nonstrategic weapon with a low yield option and an ability to penetrate, and has excellent accuracy.

The US also needs to continue investing in conventional methods for holding HDBTs at risk. The thermobaric, massive ordinance air burst, and GBU-28 are three examples of how US initiative, ability, and acquisition practices can lead to the rapid development of new weapons suitable for changing target characteristics. Other gains made by the services and private sector in penetrating weapons have been promising as well. Unconventional methods, typified by Special Forces, have demonstrated options to negate these facilities with minimal force and political attention. While all approaches have some ability to impact the function of an HDBT, none can defeat the hardest of HDBTs. Therefore, while emphasis on conventional capabilities should continue, the US must diversify its nuclear options to be a viable deterrent.

In 1946 the US was the only country with a nuclear capability. Fewer than six decades later there are at least nine countries that have nuclear programs. Great states

have risen and fallen in less time. The threats facing the US in today's strategic environment are far different than the bipolar world present in the Cold War era. States and nonstate actors pursuing nuclear weapons seek world recognition, leverage, and military advantage. There exists a greater instability among these regional powers that increases the chance of a nuclear exchange.

In the case of Israel, for example, nuclear weapons serve to dissuade the disproportionate numbers of Arab forces. Conversely, the recent nuclear brinkmanship of the Democratic People's Republic of Korea was aimed at gaining recognition, concession, and a US nonaggression pact for the survival of the Kim Jung-Il regime. Lastly, the Pakistani and Indian nuclear tests added a new dimension to a region typified by a history of conflict over the disputed Kashmir region.

These are a few of the competing motivations and strategic interests of regional powers that make the US deterrent calculus, needed to dissuade another hostile use of a nuclear weapon, extremely complex. Therefore, the US should put to practice the preemptive tenets of the NSS and the intentions of the NPR that seek to dissuade adversaries from developing military programs or operations that could threaten United States interests and develop a nuclear EPW that can defeat HDBTs in states of concern. While history will be the final judge, the present strategic environment and framework set by the Bush administration opens the door to address shortfalls against HDBTs. In relation to the emerging threat of WMD, the US National Security Strategy sums up the US responsibility to act now by stating the following:

> We will cooperate with other nations to deny, contain and curtail our enemies' efforts to acquire dangerous technologies. And, as a matter of common sense and self-defense, America will act against such emerging threats before they

> are fully formed. We cannot defend America and our friends by hoping for the best. So we must be prepared to defeat our enemies' plans, using the best intelligence and proceeding with deliberation. History will judge harshly those who saw this coming danger but failed to act. In the new world we have entered, the only path to peace and security is the path of action.

Recommendations

Feasibility Studies

The administration should aggressively pursue feasibility studies for developing nuclear EPWs. These studies should address all aspects of the nuclear infrastructure (R&D, testing (understanding the implications of open air and/or underground testing), manpower, special nuclear materials, delivery means, etc.). A critical path of the study must be to determine the suitability of using an existing nuclear warhead as a nuclear EPW. Modifying an existing nuclear weapon, the process used to develop the B61-11, is in the best interest of the US. This option would greatly reduce political backlash because there would be little need for legislative and treaty changes. Furthermore, modifying a nuclear weapon would result in far less publicity. This would give the administration the additional advantage of not having to conduct a nuclear test to verify a new design. On the other hand, a demonstration of potential would serve as an excellent deterrent. It is not yet widely accepted that an existing nuclear weapon can serve in the capacity as a nuclear EPW. For the purpose of this study, my continued recommendations are, therefore, in reference to the scenario, that feasibility studies demonstrate the necessity to manufacture a new nuclear EPW vice modifying an existing weapon.

Education

The US government would need to launch a methodical information campaign on the requirement for and effects and benefits of a new nuclear EPW. The message should

be focused on the primary need of such a system in relation to its deterrent value towards WMD. Additionally, the US government should promote the fact that a new nuclear EPW would require lower yields than existing weapons in the inventory and, due to its utility, would help expedite the reduction of other strategic weapons. A smaller, less expensive, more robust and reliable stockpile would gain favor with much of America's leadership. "Hawks" and "doves" alike could make strong arguments in favor of this new paradigm to the most cynical of constituents. Moreover, special attention should be paid to the beneficial thermal effects a nuclear blast has on a chemical or biological facility. The extreme heat generated from a nuclear weapon can vaporize chemical or biological hazards that may be aerosolized by a conventional bomb. This type of preclusion limitation analysis done by nuclear planners needs to be translated to the American public in terms they can appreciate and understand. Additionally, the current atrophy of parts of the nuclear infrastructure could be reversed, a step vital to national security. The bottom line of the campaign is that the US can reduce its nuclear weapons stockpile and simultaneously increase its deterrent value, thereby safeguarding Americans.

Key to this message is the consensus of the scientific community in reference to the nuclear effects of the new system as a factor of yield and penetration depth. Despite the advanced scientific computing initiative of the DOE that mimics nuclear explosions and the advanced plume-modeling software that predicts the flow of fallout, scientists will probably argue the nuclear effects of a new nuclear EPW. It will undoubtedly take an actual test of the weapon to come to the consensus needed to support a public information campaign. Similarly, more work should be done on the beneficial thermal effects of a nuclear weapon against a chemical or biological facility. With regards to the weapon,

every effort should be made to use the minimum required yield by increasing accuracy of target location, intelligence on the HDBT, precision of delivery, and penetration of soil.

Resume Infrastructure Development

The 1999 recommendation of the Foster Panel to increase pit production should be pursued vigorously. The small-scale ability currently residing at Los Alamos is the critical first step to resuming full production of the nuclear pits required to outfit a new series of nuclear weapons. Irrespective of the production of a new nuclear weapon, the US is currently at a huge disadvantage. Unlike the other major nuclear powers, the US gave up its ability to manufacture nuclear pits. This step is necessary for the production of a new weapon and is a critical safeguard against the inevitability of a problem with an existing weapon system attributable to years of aging.

Selective collaboration from key allies and US industry should be entertained as well. In the case of the Manhattan Project, the Combined Policy Committee was formed consisting of senior leaders from Canada and Great Britain to provide oversight and speed the development of a nuclear bomb for use during World War II. This committee demonstrated that the US could combine the strengths of other nations towards its ends. Compartmentalization of information and other security safeguards would be needed to ensure the integrity of the overall program, however. This collaborative effort would also serve to achieve a key political milestone. Information sharing is vital to multilateral approval of a new nuclear EPW, a step that otherwise would be viewed as provocative by the nation and the international community, especially if undergone unilaterally.

Nuclear Weapons Policy

A geographic combatant commander could request and employ a nonstrategic nuclear EPW in his theater against an HDBT. This target could be in a remote area and confirmed as a biological facility by several intelligence sources. Additionally, its location and the current weather conditions prevent any collateral damage associated with nuclear blast, thermal, initial, or residual radiation. This is an ideal scenario for a nuclear EPW. Unlike a strategic nuclear attack, a low yield nuclear EPW dropped from an aircraft and guided precisely onto a known target is not too dissimilar to a conventional attack. It is reasonable to conclude that the geographic combatant commander should have such authority and flexibility to do so.

Currently, nonstrategic nuclear forces employed in support of a geographic combatant commander follow the same policy constraints as strategic nuclear forces. A new nuclear EPW is not cause for change to this policy. Presidential approval, the cornerstone of nuclear command and control since the Truman administration, must remain. Nonstrategic weapons, despite a small yield and limited collateral effects, will have strategic consequences in terms of the political environment, world opinion and support, and the economy. Subsequently current nuclear command and control procedures should remain intact.

Targeting

Increased intelligence efforts and techniques against HDBTs are key to the effectiveness of a nuclear EPW. For instance, according to Major Wittig (personal interview 19 March 2003) CENTCOM planners viewed live imagery of bomb strikes in Afghanistan to watch for venting of smoke or flashes of light from conventional bombs

and then would reengage these portals, ensuring that all entrances to tunnels were destroyed. This technique would confirm tunnel characteristics and portals provided by the intelligence community and ensure that follow-on attacks destroyed all remaining portals. Similarly, precision-guided munitions allow for the dropping of penetrating bombs in succession and proximity to attain greater depth. Lastly, conventional bunker-busting and cratering devices can be used initially to allow greater penetration for a follow-on nuclear EPW. Incorporation of these techniques into nuclear targeting may help keep the nuclear yield required to a minimum.

Amendments to Legislation

The amendment to the Fiscal Year 1994 Defense Authorization Bill by Elizabeth Furse (former Democrat from Oregon) and current senior member of the House Armed Service Committee John Spratt (Democrat from South Carolina) should be immediately revoked. This legislation prohibits the design and development of a nuclear weapon of less than five kilotons. At the time this legislation was crafted in the early 1990s, it was the consensus of Congress that if the US had a low yield nuclear weapon it would more likely be used. This thought process is key to deterrence and is exactly what is needed to counter WMD threats today. Combined with the current administration's preemptive policy and demonstrated actions to seek out terrorists and those who harbor them, this former concern of Congress may now be the exact message they would choose to promote. Since 11 September 2001, it is clear that it is better to have systems that assure the safety of Americans by holding adversaries centers of gravity at risk than not to develop them for fear that they may be required.

Similarly, the self-imposed nuclear testing moratorium would need to be dissolved. Testing would be necessary to assure the President that a new nuclear EPW functions and is effective in relation to the military characteristics it was designed to achieve. Similar to the March 2003 testing of the massive ordinance air burst bomb in Florida, a new nuclear weapon should also be tested because of its effective deterrent value. A successful demonstration of a nuclear EPW would be a huge deterrent to countries that are reliant on underground facilities for their survival. As stated in previous chapters, funding has been diverted to reduce the amount of time required to conduct a US nuclear test. Steps are in progress to expedite this process.

Lastly, as one of the five NWS in the NPT, development of a new nuclear weapon is not consistent with Article VI of the treaty that states all signatories will pursue complete disarmament. While it is clear by the recent agreement with Moscow that the US is pursuing this ultimate objective, it will undoubtedly encounter severe criticism upon resumption of a new nuclear weapon program. Actually, the US will never completely disarm if it jeopardized national sovereignty. Therefore, while developing a new nuclear EPW may seem contrary to the NNPT, it is a necessary step for US national security and does not prohibit the current reduction of strategic systems.

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